Space Weather Technical Forecast

Issued on Tuesday 14 January 2025 at 01:08 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight Chance of isolated M-class flares, slowly increasing. HSS enhancement likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low during the last 24 hours with only C-class flares recorded.

There are eight sunspot regions on the visible disc. AR3947 remains the most magnetically complex group, the evolution for this region appears steady however, or in slight decline. AR3959 continues to move into view around the northeast limb, with the initial classification of Hhx/Alpha so far maintained until we see any more evidence of a trailing portion, which could suggest an increased flare risk. A new region is also emerging from around the southeast limb. Other regions remain smaller and simple with limited overall change.

No Earth-bound CME's were observed during this period.

Solar Wind / Geomagnetic Activity: Solar winds observed at L1 by ACE/DSCOVR rose erratically through the period to slightly elevated levels with the likely onset of the HSS of CH08/- and potentially some transitory CME influence. They ranged between 380-480 km/s. The density of the solar wind was mainly average to below average. The Interplanetary Magnetic Field, Bt, was initially at moderate levels, with a peak of 13nT around 13/0600 UTC. Since then it has steadily declined to weak levels. The north-south component, Bz, varied weakly between -6nT and +11nT. The Phi angle was initially positive (away from the Sun) but became negative (towards the Sun) from around 13/0400 UTC. Geomagnetic activity was mainly Quiet (Kp1-2), with an isolated Active (Kp4) interval 13/0000-0300UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES-18 was at background levels. High energy electron flux (greater than 2MeV) at GOES16 was at background to moderate levels. The associated 24 hour fluence remained below the Active threshold on a generally downward trend, reading 2.65e6 integrated pfu at 14/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low, with a slowly increasing chance of isolated M-class flares and a very slight chance of isolated X-class flares, mainly due to AR3947 in the northwest disc or any spots that rotate over the eastern limb later in the period.

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Solar Wind / Geomagnetic Activity: Solar winds are currently slightly elevated, with observed speeds now around 420-450 km/s. The expected source is thought to be a HSS enhancement associated with CH08/- in the west of the disc. Speeds most likely remaining at slightly elevated to elevated levels through Day 1 (14 Jan), before easing Days 2-3 (15-16 Jan). A connection to CH09/- is then possible from Day 4 (17 Jan), with solar winds likely increasing once again.

Geomagnetic activity is expected to be mainly Quiet to Unsettled (Kp1-3) throughout, but with a chance of Active (Kp4) intervals, most likely on Days 1 (14 Jan) and 4 (17 Jan) in association with coronal hole HSS enhancements.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to remain at background levels, with only a slight chance of rising in response to any notable flares. GOES-16 high-energy electron flux is anticipated to remain at background levels due to ongoing and future HSS influences. Electron fluence is expected to remain below the active threshold throughout.

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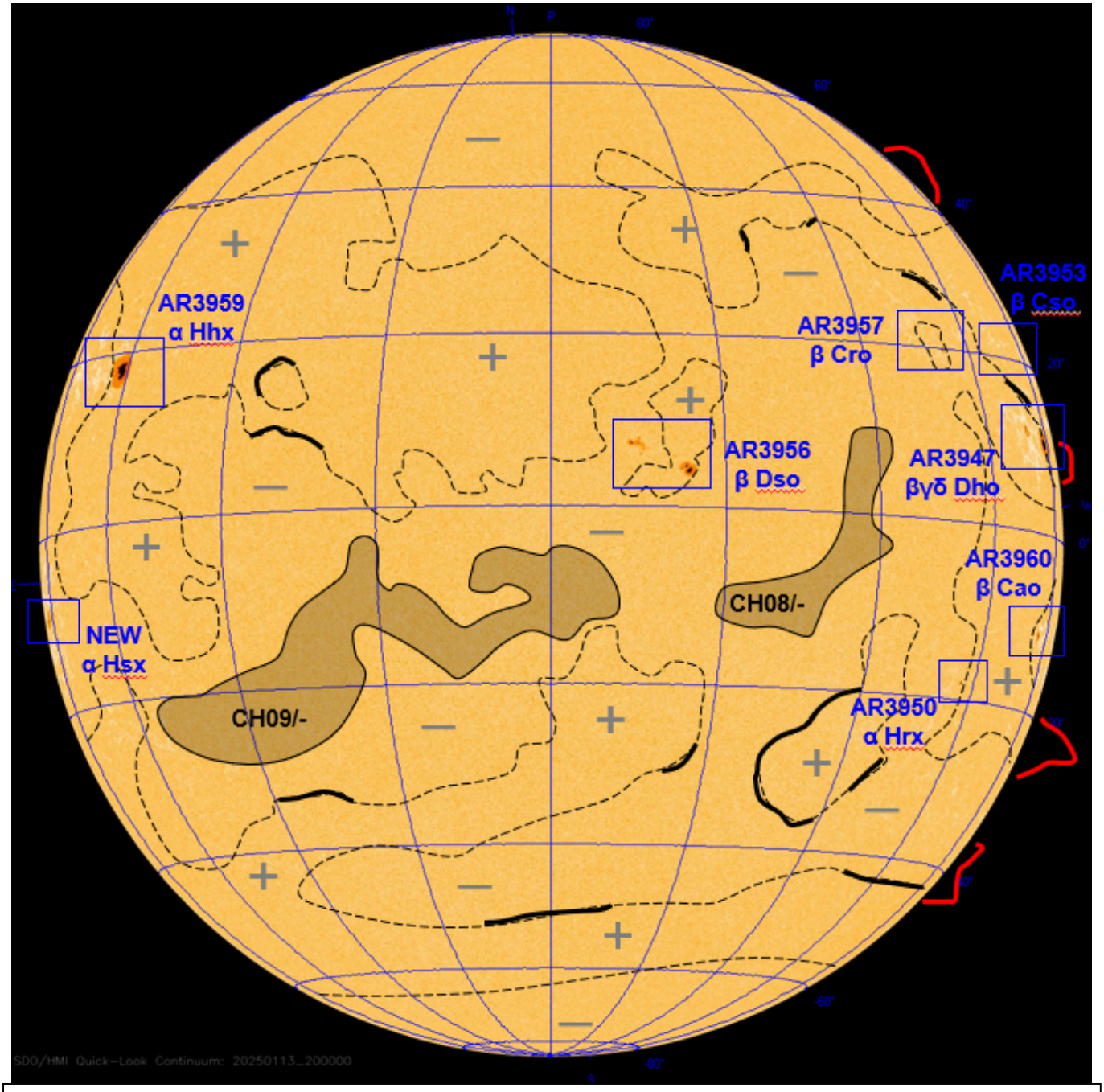
Figure 1: Solar Synoptic Map valid 13/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Solar winds are slightly elevated, with observed speeds now around 420-450 km/s. The expected source is thought to be a HSS enhancement associated with CH08/- in the west of the disc. Speeds most likely remaining at slightly elevated to elevated levels through Day 1 (14 Jan). This evolution notably different than indicated by MOSWOC's ENLIL model, which appears to overestimate both the onset time and longevity of CH08/-, as well as the associated HSS speed, with solar wind speeds expected to gradually decrease back to background from Day 2 (15 Jan). This may prove brief however with a connection to CH09/-, currently lying just south and east of the equator, possible on Day 4 (17 Jan).

There is the possibility for solar winds to remain slightly enhanced throughout the forecast period, as CH08/- and CH09/- were initially one large and elongated coronal hole. Whilst imagery would suggest they have split into two discrete coronal holes over the past few days, flux lines in imagery may be obscuring a connection between these two regions, hence the possibility for the ongoing enhancement to continue longer than currently thought. This is low confidence however.

No CMEs feature in the forecast currently. Any CME from the filament eruption of 09 Jan would likely have reached Earth by now, perhaps doing so as a transient feature over the past day or so, explaining some of the fluctuations in solar winds speeds.

Geomagnetic activity is expected to be mainly Quiet to Unsettled (Kp1-3) throughout, but with a chance of Active (Kp4) intervals, most likely on Days 1 (14 Jan) and 4 (17 Jan) in association with coronal hole HSS enhancements. There remains a very slight chance of isolated G1 Minor Geomagnetic Storms (Kp5) on Day 1 should any significant CME influence be forthcoming.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	5	1	1	5
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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Radio Blackouts - X-Ray Flares

Solar activity has been Low during the last 24 hours with only C-class flares recorded.

There are eight sunspot regions on the visible disc. AR3947 remains the most magnetically complex group, the evolution of this region appears steady or in slight decline. AR3959 continues to move into view around the northeast limb, with the initial classification of Hhx/Alpha so far maintained until we see any more evidence of a trailing portion, which could suggest an increased flare risk. A new region is rotating around the southeast limb, however classification is tricky until it moves further into view. Other regions remain smaller and simple with limited overall change.

Evidence of magnetic looping in SDO 171 imagery near the eastern limb suggests the potential for new regions to rotate onto the facing-disc in the coming days. Helio-seismic data is supportive of this and corresponds to expected locations for Ex-AR3933 and Ex-AR3936. These two regions were responsible for M-class flares when last on the disc in late December. AR3947, which currently dominates flare probability contributions, will rotate over the western limb through Day 1 (14 Jan) with a gradual decline in flare risk from this region thereafter.

Overall, a slight chance of isolated M-class flares initially, this risk steadily increasing to a chance through the period as further regions are expected to rotate on. The risk of isolated X-class flares very slight but also increasing.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	25	30	35	40
Very Active	R3-R5 (X Class)	No	5	5	10	10

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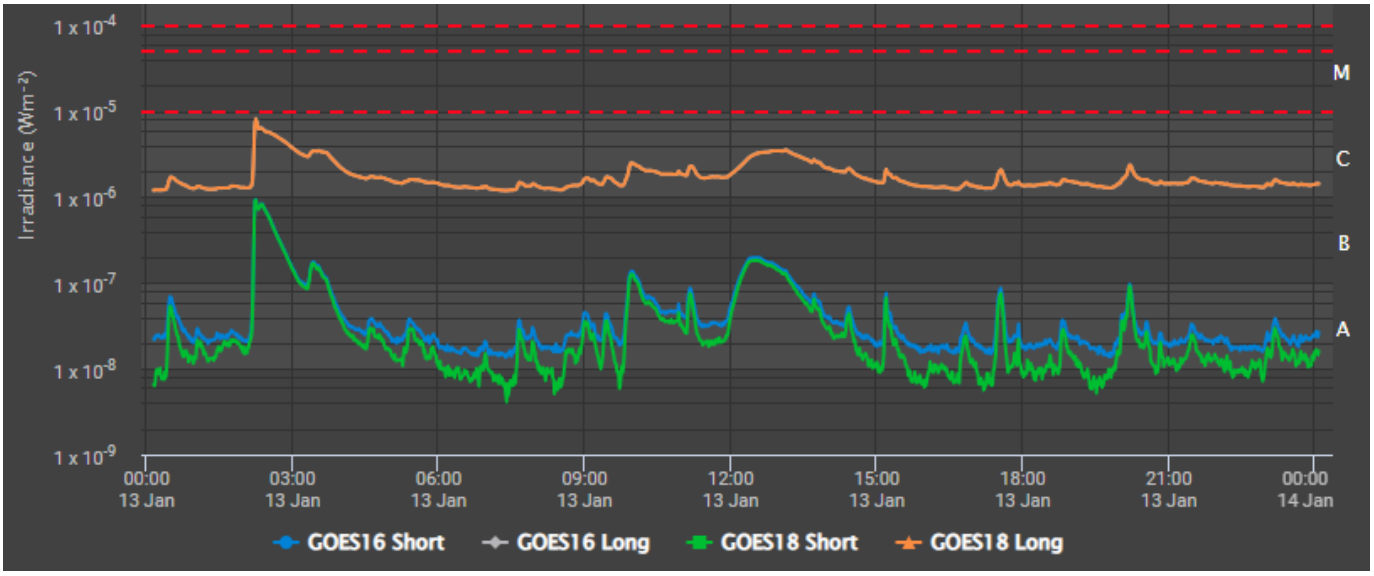
Figure 2: GOES-16 & -18 X-ray flux.



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Solar Radiation Storms (High Energy Protons)

GOES18 high energy proton flux has remained at background over the last 24 hours. There is a slight chance of an enhancement as AR3947, the most complex spot, continues to transit the western hemisphere during the forecast period, rotating off of the visible disc during Day 1 (14 Jan) but will still present a risk of enhancement though the period. This region was previously the source of multiple M-class flares and isolated X-class flares, but with a reduction in significant flares recently. Risk expected to increase slightly later into the period as further sunspot regions are expected to rotate onto the disk, with a continued threat from AR3947 even as it rotates away.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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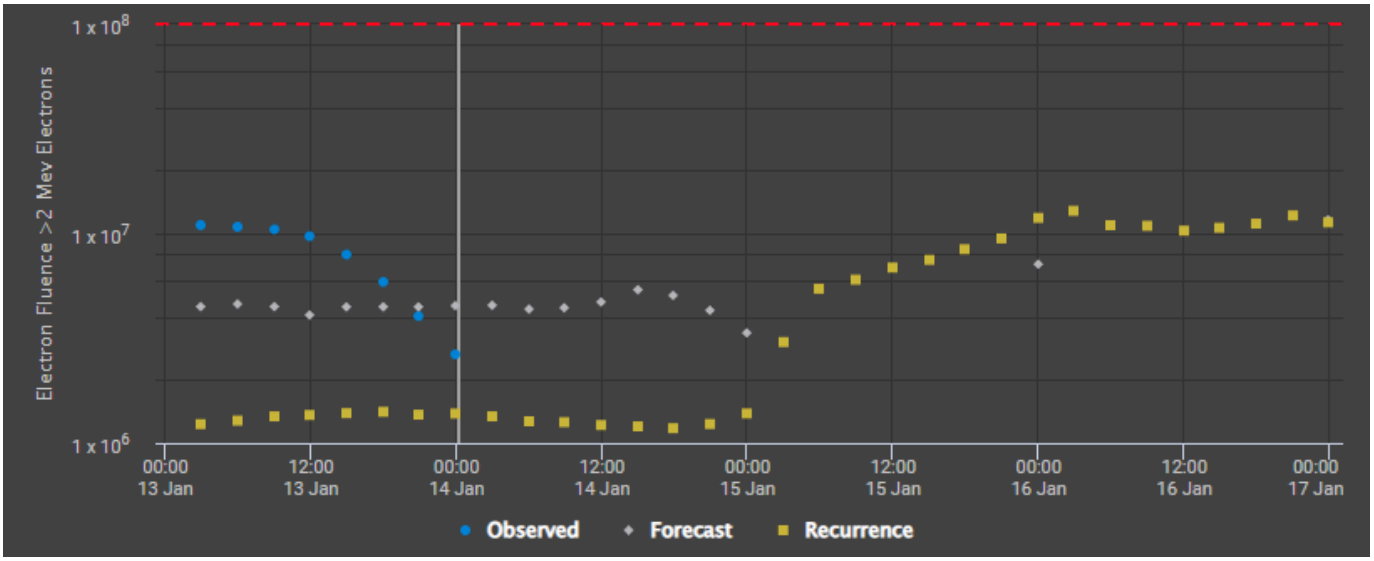
High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has been at normal to moderate levels during the past 24 hours. The ongoing arrival of the HSS from CH08/- early in the period is expected to suppress the electron belts away from GEO. Flux levels potentially returning to moderate to high levels towards the end of the period, however any connection to CH09/- is then likely to suppress electron belts once more.

Electron fluence is expected to remain below the active threshold, with REFM currently serving as a reasonable guide. There is a slight chance of a slight rise later in the period, although this is low confidence.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^8	No	1	1	1	10
Very Active	≥ 2 MeV ≥ 1×10^9	No	1	1	1	1

Figure 3: MOSWOC REFM



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